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EDITOR
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University of Toronto, Toronto

ASSOCIATE EDITORS
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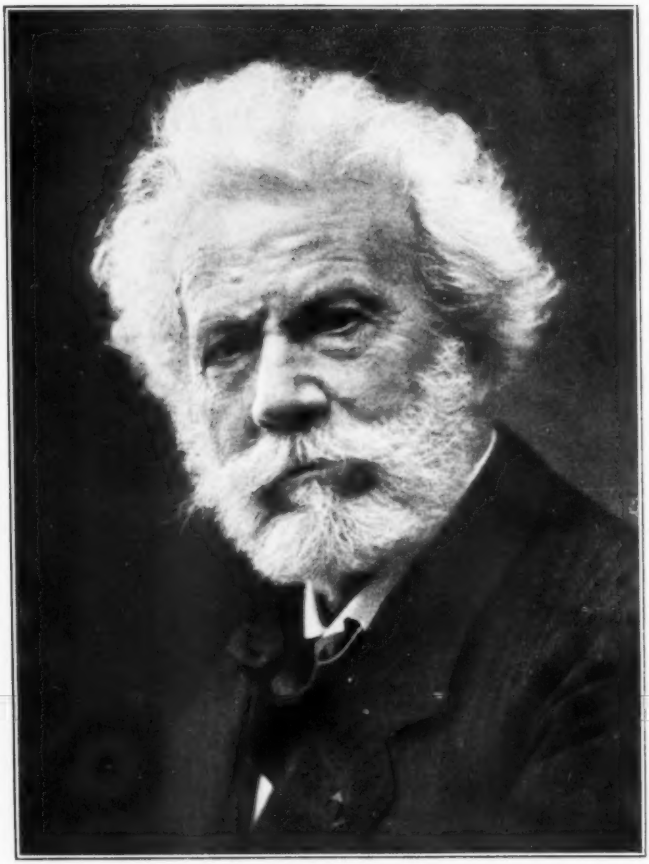

Camille Flammarion
1842—1925
From *L'Astronomie*, July 1925

THE JOURNAL
OF THE
ROYAL ASTRONOMICAL SOCIETY
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VOL. XIX DECEMBER No. 8-9-10

CAMILLE FLAMMARION: HIS LIFE AND HIS WORK

By A. F. MILLER

WHEN a child, born under conditions that assure for his later years those great advantages wealth and social position confer, achieves on reaching manhood a high standing in literature, in science, or in art, we are ready to grant he must have possessed talent, genius.

When on the other hand a child born to parents in very moderate, even humble, circumstances, and in the lower social rank, gains wide and favourable recognition as an author before reaching his twentieth year, and within the ensuing decade achieves world-wide celebrity as a man of science, and no small reputation in the realm of art, we feel compelled to acknowledge he possessed more than ordinary talent. And when we further learn that, thrown on his own feeble resources while a mere child, by his indomitable courage, resolution, and industry, he not merely won his way to eminence as one of the best-known and most popular of writers in this era of much book-making, and recognition as a leader of scientific thought everywhere, but also inaugurated and carried to an advanced stage a great and ever widening scheme for educational and social advancement in the land of his birth, (and from thence extending a benign influence throughout all civilized lands,) we feel we do him only justice when awarding to him the wreath of superlative genius.

For CAMILLE FLAMMARION, the subject of this sketch, was not "born in the purple." His father, Etienne Jules Flammarion, was a 'cultivateur,' who occupied a small farm near

Montigny-le-Roi, principal town, or rather, village, of the Department of La Haute-Marne, a district known for a cold climate and a none too fertile soil. At the time of which we are speaking the "town" had but 1267 inhabitants. His mother, Francoise Lomon, though possessing "some aristocratic tendencies," helped the family affairs by carrying on a small business of drapery and mercery in the town. There, on Saturday, February 26, 1842, her first-born son Camille saw the light. He was destined to be the eldest of a family of four children, a sister, born two years later, a brother born after a similar interval, and another sister born last of all.

From infancy the little Camille was a handsome and highly intelligent child, whom his mother with "aristocratic tendencies" forbade to play with "common children", foreseeing for him by some prophetic instinct a special destiny and a glorious career. To further this ambitious view the parents resolved he should have a good and solid education; so he was early sent to school, where he soon displayed intelligence beyond his age. At 4 years he could read fluently; six months later he could write, and at 5 he had made good progress in grammar and arithmetic, At 6, he was head of his class, and knew by heart nearly the whole of the New Testament. The ambition of his fond and pious mother was to have him enter holy orders; and he tells us himself (we fancy with a smile), that many years later, when her son had become one of the most noted men of his time, she still regretted he had not become *a priest*. Curiously enough, she herself directed his childish mind toward that science, the pursuit of which was to dominate his future career.

It happened thus: On October 9, 1847, occurred an annular eclipse of the sun visible at La Haute-Marne, and the event was announced beforehand in the newspapers. His mother resolved that her clever boy should see the phenomenon; she therefore placed a pail of water in front of her house, which faced the east, and by reflexion from the liquid surface the youthful astronomer was able to make his first observation. On July 28, 1851, another eclipse occurred, total at Berlin, largely partial at Montigny-le-Roi. This eclipse was observed by similar arrangement of the convenient water pail, supplemented by a piece of smoked glass. On this

occasion the sister, aged 7, and the brother, aged 5, were "assistant observers." Camille himself had reached his ninth year.

The interest aroused by the former eclipse was intensified by the later one. How was it known when eclipses were to happen? How could such things be foretold long before they occurred? He put these questions to all his friends; they could not tell him. So he sought for the desired information (to him then) the source of all knowledge—the village schoolmaster. This worthy man could only tell him that there were *savans*, called astronomers, who were able to foresee eclipses and other celestial events by calculations involving geometry and algebra, lofty branches of the tree of knowledge only known to the good man himself by hearsay. But as the boy continued to pester him with questions, he hunted up a work on cosmography and lent it to his inquisitive pupil, who read it eagerly, though at first without much comprehension; but to overcome that obstacle, copied the book page by page. "I was profoundly moved," Flammarion later wrote, "and filled with admiration that *savans* were able to calculate in advance the movements of the stars (*les astres*) in the heavens." Thus was kindled in his boyish mind the magic spark which was to fire his whole soul, and from him kindle a similar flame in thousands of others. A wise man once wrote the words: "Whatever man has done man may do." Unconscious of the proverb, the nine-year-old boy developed the idea for himself. *Savans* could predict the movements of the stars by astronomy; *he* would learn to do it also. Their methods were geometry and algebra; *he* would acquire those arts as the means to reach the desired aim.

Permit me at this point to depart widely from chronological order by referring to a total solar eclipse (only one of several Flammarion witnessed), which occurred in August, 1905, 54 years later than the time of which we have been speaking, and when our child-observer had passed his 60th year. As this particular eclipse could be observed under most favourable conditions at a station in Spain, many astronomers, and a large group of amateurs, chiefly members of the Astronomical Society of France, travelled thither to witness it. Flammarion, as Founder of the Society and acknowledged leader of unofficial French astronomy, was named

director of the party. On arriving at their destination their Spanish confrères hailed them as *"Los Flammarions,"* and the newspapers bracketed the whole assemblage under the same term. The day before the eclipse the Spaniards entertained their visitors at a banquet, when naturally the subject of the probable weather conditions on the ensuing day was discussed with some anxiety. An eminent Spanish poet who was present, rose, and addressed Flammarion in an improvised quatrain, which I thought so appropriate as well as clever, it impressed itself on my memory, and as it would lose much of its charm by translation, I must repeat it in the poet's own words:

"Maitre renommé et sage,
Nous faisons cette prière solennelle;
Q'il ne vienne à toi aucun nuage
sur la terre ou dans le ciel."
(Master renowned and wise,
We pray the Powers on High,
For thee may no cloud arise
Either on earth or in the sky.)

Needless to say, the weather conditions during the eclipse were exceptionally favourable.

And now, asking pardon for this digression, I return to the narrative of the boy-astronomer.

At 9 years, having passed the highest class in the primary school, he commenced the study of Latin, his tutor being the parish *curé*, and made rapid progress. This quite accorded with the plans of his mother, who wished him to enter the priesthood. In 1852, aged 11, he was placed at the *Maitrise* of the Cathedral of Langres; but a fine comet which appeared that year further developed his passion for observation. He followed its movements from night to night and made a drawing. During this and the following year he became interested in the formation of fogs and their effect on the visibility of Mont Blanc. In one of his works he mentions that about this time there fell into his hands a monograph on the constellation of Orion, entitled *Flamma Orionis;* he saw in the title a resemblance to his own name, which he regarded as a good omen. Always interested in the workings of

Nature, he observed the transformation of chrysalides into butterflies, and wrote notes as to this curious process.

Thus Flammarion's school-days were passing calmly and profitably. But during 1856 an event occurred destined to change the whole course of his life. By a sudden misfortune his parents lost their little property and found themselves "completely ruined." They decided to go to Paris in search of livelihood, leaving Camille for the time being to continue his studies, the worthy *curé* having undertaken the expense. But living in Paris was dear and the household budget hard to balance, the father having only a poor employment in a photographic establishment; so the parents reluctantly decided their boy must be taken from school and put to a trade to assist in keeping the family. Thus ended Flammarion's school-days.

He journeyed to Paris, arriving on September 4, 1856. He had been expecting to behold a city of dazzling palaces, and was keenly disappointed with the dull and dingy houses of Faubourg Saint-Martin. After weeks of search, and not without considerable difficulty, a place was found for him as apprentice in the shop of an engraver and chaser of metal-ware. The lad was to be given food and lodging for his work; needless to say, there was no mention of salary. He remained there during the rest of 1856, the year 1857 and the winter of 1858. The work was heavy, having nothing intellectual or artistic. On the apprentice devolved the drudgery of the work-shop, the fetching and carrying, and the outside errands. His prospects for education seemed blasted, but he did not abandon hope. He found he could enter the night-classes of the *Association Polytechnique,* and a course in design at the night-school of The Brothers of Saint-Roch. Thus commenced a systematic course of self-education by night study. The day's work finished, he resolutely climbed the stair to his "mansard" to continue his self-imposed tasks, perfecting his knowledge of algebra and geometry and learning English without a teacher. Never lying down to sleep before midnight, calculating, reading, writing, by the light of an end of candle, he toiled on with unflagging resolution. He recalls that more than once when a candle-end could not be obtained he read or wrote by the light of

the moon. By diligent search through the old-book boxes of the *Quais* along the Seine he managed to assemble quite a library of old discarded books. Having secured for almost nothing a few copies of the *Annuaire des Longitudes,* and found the scientific articles valuable, he contrived to complete the series from the foundation in 1796. He confesses, however, that he had often to turn away sadly disappointed when the price of some coveted volume exceeded 20 or 25 centimes, (4 or 5 cents). Despite his humble condition and poverty he clung to the hope of passing his baccalauriat.

But such incessant and severe strain, physical and mental, was too great for the strength of a boy of sixteen. In May, 1858, young Flammarion fell ill. As fate would have it, this illness brought about one of his fortunate chances. The doctor who attended him was not only skilful, but intelligent and kindly. Casting his eye round the poor and scantily furnished mansard, he noticed with surprise the little table with writing materials and the collection of old books. But what riveted his attention was a thick MS. volume of 500 pages entitled *Cosmogonie Universelle,* written at night by his boy-patient after the day's toil in the workshop below. It will not be out of place to mention here, that nearly 30 years later, this work, rewritten and greatly modified, appeared in a splendid edition, under the title: *The World Before the Appearance of Man.* Such an instance of intelligence and genius surprised and delighted the excellent doctor. He related the discovery to scientific friends; and after a while, when revisiting his patient, told him that if he were to call on M. LeVerrier, director of the Observatory of Paris, he would probably be permitted to enter that famous institution as pupil-astronomer. As soon as possible Flammarion availed himself of the opportunity thus offered. On Friday, June 26, 1858, he was received by the great astronomer in his private study. Pleased with his appearance and intelligence, LeVerrier referred the applicant to "the learned Professor," M. Victor Puiseau, who propounded to him various questions; and the replies being judged satisfactory, the Director announced to him that on the following Monday, June 28, 1856, he would be received at the Observatory as pupil-astronomer, with a salary of

50 fr. a month during the first year. Flammarion's own words must be quoted to express his feelings. "I went out of the Observatory on wings. The Avenue of the Observatory and the Garden of the Luxembourg seemed to me a paradise, a celestial country of which I had become a citizen; and I felt I was now entering the road I had so long sought."

Behold, then, the young astronomer admitted to the temple of Urania, brimful of enthusiastic hope, believing that from henceforth his heart's desire to gain a full acquaintance with the profound secrets of astronomy would be gratified without reserve. It so happened that at this identical time the great comet of Donati appeared. He watched it with intense interest and made a drawing from the terrace of the Observatory. Doubtless he would have been delighted if some instrument had been placed at his disposal, but no such opportunity was granted. Observing was not any part of his duty.

And indeed the young enthusiast should scarcely have expected that matters would be arranged to meet the desires of a novice whose first wish was to scrutinize and admire the marvels of the heavens. Assigned to the Bureau of Calculations, he found himself tied down to mechanical computations which had nothing according with his temperament or tastes. True, he found mathematical astronomy deeply interesting, and the *Mécanique Céleste* "admirable"; but, still, he longed for opportunity to observe, to conduct researches of more real living interest, with a touch of the poetical. He saw the transit, the mural circle, and the great meridian instrument designed by LeVerrier himself, used in making observations which it was his duty to "reduce." He knew that in the domes surmounting the majestic (though unsuitable) building of Colbert were large telescopes, any one of which would have opened for him the portals of heaven. He may have hinted his aspirations; if so, he doubtless was snubbed. His visions were less rosy than at the outset. So passed the years 1858 to 1861. However, there were compensations: The hours of duty in the *Bureau des Calculs* were short, terminating at 4 p.m. daily, so he had thus a good deal of spare time. He completed the necessary course of studies, and was successful in taking his baccalauriat in sciences

and in letters, thus attaining the goal of his early ambition. Then he resumed his efforts at authorship, producing a voluminous MS. descriptive of "A Voyage to the Moon!" His own judgment of this work, in later years, was that it was not worth publication.

But his untiring pen did not stop there. Another MS. volume followed, in which he presented ideas sometimes original, sometimes borrowed, sometimes more fanciful and poetic than strictly scientific, yet for all, not devoid of scientific basis. He felt this work possessed merit, and longed to see it in print. It happened that when carrying the corrected proofs of the *Annales de l'Observatoire* to the establishment where they were printed he had formed a friendly acquaintance with M. Bailleul, the foreman, and one day he ventured to slip in a chapter of his own manuscript along with the Observatory proofs. M. Bailleul read it with astonishment, hardly crediting that one so young could be the author of a scientific work. He asked to see the other chapters, and not long after apprised Flammarion that the printing-house Mallet-Bachelier were disposed to publish the work. Accordingly, a few months later an edition, 500 copies, of *La pluralité des Mondes Habités* duly appeared. The book obtained an immediate and wonderful success, the first edition being quickly exhausted. The young author by a single step took rank as a popular writer; everyone commended his work—except the Director of the Observatory of Paris.

LeVerrier, learned, clever, famous, was by nature harsh, domineering, despotic. His character was summed up in a single word, "terrible". Disliked, dreaded, by his subordinates, he was cordially hated by many outside the institution. That a member of the Observatory staff should have presumed to publish a book such as "La Pluralité" aroused his anger. Summoning the offender to his presence, he said in a tone admitting of no reply: "I see, Monsieur, you do not desire to remain here. Nothing is more simple; you may take yourself off."

These rude and cruel words deeply wounded the sensitive young man, whose brilliant expectations and hopes were destroyed in a moment. Conscious he had done no wrong, LeVerrier's despotic act aroused his resentment, and though neither spiteful

nor revengeful by nature, he exclaimed in bitterness of soul as the heavy doors closed behind him for the last time (as he then supposed): "He has sent me away; he shall be sent away."

His dismissal from the Observatory actually proved a blessing in disguise. The kindly M. Baillaud, the present Director of the Observatory, has even charitably suggested that LeVerrier realizing this, took the step in the young man's own interest; but that may be doubted.

Flammarion, poor and friendless, was acute enough to turn the Director's unpopularity to his own advantage. Posing as "the latest victim" of that terrible person, he secured the good offices of those inimical to LeVerrier. Delaunay introduced him to the president of the *Bureau des Longitudes*, who at once received him as a member of his staff. He was made a computer, charged with the calculation of the lunar positions for the *Connaisance des Temps*. During 1862 and 1863 the new computer determined the value of the Moon's R.A. and Decl. for the years 1866 and 1867.

But the favourable reception accorded by the public to his book attracted to the young author the attention of several editors of magazines and reviews, and brought him numerous solicitations to engage in journalism. His first essay in scientific work of this kind appeared in the *Revue Francaise* of February 1, 1863. Four months later he undertook the scientific editorship of *Cosmos,* to which, till 1869, he regularly contributed articles on astronomical and meteorological subjects. It also so happened that there appeared in that review a series of short but pungent criticisms of LeVerrier, and these continued till 1870, when the Director resigned.

In the first edition of *La Pluralité des Mondes* from the press of the official printers to the Observatory, certain passages had been omitted, contrary to the author's wishes. Another publisher now arranged to bring out a new edition in octavo, in which the author took care that the omitted portions should be restored. This edition was also quickly exhausted, and the same year it was found necessary to meet the popular demand by the issue of a third edition in 12-mo.

Flammarion, now fairly launched on the broad ocean of scientific journalism and literature, definitely withdrew from the routine of

public officialism, devoting his undivided attention to scientific authorship. He published in the *Annuaire* of *Cosmos* several important essays, among which might be mentioned: "A discourse on the destinies of Astronomy," (1864); "Stellar Astronomy," (1865); "Unity of Energy and Matter," (1866).

In 1864 the *Magasin Pittoresque* secured him as collaborateur, and he drew up a chart of the planetary positions which appeared in January, 1865. This was the commencement of an "Astronomical and Meteorological *Annuaire,*" which was continued in that journal from 1865 till 1884. From 1885 till 1892 it appeared in *L'Astronomie;* then, from 1893 till 1925, (the year of his death) it was issued in the form of a small annual volume. Thus, during 61 years he compiled and edited this valuable work, (which yielded him no pecuniary profit,) solely for the benefit and encouragement of unprofessional observers.

Flammarion's second book, "Imaginary and Real Worlds," written in 1874, came out the following year. While somewhat fanciful, it contained much valuable matter based on scientific reasoning, and skilfully presented in elegant language. Then, in July, 1875, appeared *Les Merveilles Célestes,* known to English readers as "Wonders of the Heavens." This little volume, one of the most pleasing and effective of Flammarion's works, gained immense popularity, and has been largely instrumental in arousing that general interest in astronomy which, during the past 40 years, has continued to extend a beneficial influence throughout the civilized world.

Though now become a very hard-working literary man, Flammarion recalled with deep gratitude the help accorded him during his early years of poverty and struggle by the *Association Polytechnique.* A pupil then, he now became a professor, and also delivered a series of very successful public lectures on behalf of the Association. He gave valuable services gratuitously to other similar educational objects, of which space forbids more than mere mention. About this time appeared his book, *Lumen.* Rather fanciful, it was well received by the public, especially in France.

The popularity of the young astronomer steadily increased, and his collaboration was solicited on all sides by editors of magazines

and reviews. His first contribution to a daily, *Le Siècle,* appeared in January, 1866, the subject being, "The application of spectrum analysis to the study of the celestial bodies." For several years he continued to contribute semi-monthly articles to this paper. But his talent was also in demand for other journals of the highest class, too numerous to name in detail.

During the same year Flammarion undertook a course of public lectures, illustrated by lime-light projection of special photographic slides and delivered at intervals of 15 days. He had all intellectual Paris as his audience, and the course was a complete success. I should mention here that later he delivered lecture courses in many of the principal cities of France, as well as in the large cities of other countries in Europe. In every case his lectures were appreciated, and aided greatly in the popularization of astronomy.

Thus far Flammarion had been obliged to depend for information on the observations of others, though ever since his dismissal by LeVerrier he had longed for opportunity to make observations of his own. He now rented premises in Rue Gay-Lussac, where he installed a refractor of 0.108m., (4.3 in.) and at last found himself possessed of "an observatory of his own." (An illustration in his "Popular Astronomy" gives the impression that he was obliged to make his observations from the roof of a house.) Nova Coronæ 1866 appeared, and he carefully followed its light variations.

In 1867 Flammarion, having collected the large number of scientific articles he had contributed to the journals previously mentioned, combined them in a volume entitled: "Studies and Readings in Astronomy." This compilation, very favourably received by the reading public, was continued in nine similar volumes issued between 1867 and 1880, many of his original observations and researches being included in the series.

Hitherto in this paper we have been regarding Flammarion chiefly as a popular writer and lecturer. We must now mention his return to the Observatory of Paris, and his important work done there as an observer of double and multiple stars.

LeVerrier resigned the directorship of that institution in 1870, but returned in 1873, and remained in office till his death four years later. During his retirement he is said to have "gained

wisdom." Anyway, he realized he had acted unwisely by incurring the enmity of a man very highly thought of and much in the public eye. He sent for Flammarion, expressed regret for the past, and offered him the use of the equatorial in the east tower. Thus a reconciliation was effected. Flammarion, (who thereafter refers to LeVerrier as "the illustrious,") accepted the offer and returned to the Observatory as an observer without salary. He had noticed that while there existed many catalogues of the results obtained by individual double-star observers, no *résumé* of all these had as yet been compiled. He therefore took on himself this onerous task; and having rented an apartment in the vicinity of the Observatory, commenced the formation of his "Catalogue of Double and Multiple Stars," published in 1878. Space will only permit me to speak in the most cursory way of this great and successfully executed undertaking, which not merely demonstrated in the most striking manner Flammarion's remarkable ability as an observer, (since he had acquired the necessary *technique* solely through the use of a small telescope, ill adapted for such difficult work), but also forms a monument to his untiring industry, skill, patience, and talent as a compiler. This important catalogue, now become very scarce, is still valued by double-star observers everywhere as a veritable fount of information graphically and charmingly expressed. Two incidents occurred while Flammarion was labouring at this self-imposed task, which I cannot forbear mentioning. Having noticed the irregular and extraordinary movements of the third star in the triple system of Zeta Cancri, after many attempts to reconcile these complex motions with any mathematical theory, he communicated his interesting discovery to Faye, the brothers Henry, and other astronomers; but before presenting the results to the Academy of Sciences he desired to have them confirmed by an observer of high standing; he therefore sent full particulars to Otto Struve, director of the Poulkowa Observatory. The "Germano-Russe" *never replied,* and a few months later reported the discovery to the Academy as an original one of his own. But this disingenuous action only resulted in an exposure of his dishonourable conduct, Flammarion having deposited with the Secretary of the Academy, before applying to Struve, a sealed

envelope containing his measures and results, which document settled the right of priority and independent discovery as being entirely due to Flammarion. The second incident, which should be related before quitting this part of my subject, is an instance of the official petty jealousy of which Flammarion was made the object. Just at the time of LeVerrier's death Flammarion was investigating some peculiarities in the elements of the double, 85 Pegasi. Going to the Observatory that evening as usual to continue his measures, he found the dome locked and the key removed, "by order of the Director *pro tem.*" The season during which the star could be observed was drawing to a close! Flammarion wasted no time in argument with the person who had taken such paltry advantage of his "little brief authority," but at once wrote to Burnham, asking him to make the desired measures. The great double-star observer complied with the request the very next night, and not merely sent Flammarion the information he desired, but was able to tell him, in addition, that the *companion was itself a double.*

We now come to another branch of science somewhat closely related to astronomy, in which the indefatigable observer was interested. Not merely occupied with contemplation of celestial bodies, he had from his earliest years admired and wondered at *the sky* which forms their apparent background. In this way he had associated with his astronomical observations careful and systematic meteorological observations also. He formed plans to compose a great work on *The Atmosphere,* and had collected material from every available source; but desired before giving definite shape to his plans, to make investigations on the spot, so to speak, through actually visiting the higher regions of the air by balloon ascensions. There was at that time in France an Aerostatic Society, of which Flammarion had long been one of the most active members, but the Society neither possessed a balloon nor funds adequate to purchase so expensive an appliance. In this difficulty it was discovered that in one of the military stores there was packed away an excellent balloon, which, intended for observation purposes during the Franco-Austrian war in Italy,

(1858-9), had never been actually used. The Minister of War granted the use of it for scientific purposes, through which favour Flammarion was enabled to make twelve entirely successful balloon voyages, during which he carried out a long program of observations, alike of deep interest and great scientific value. The first of these "voyages in the air," undertaken on "Ascension Day," May 30, 1867, was relatively short. The other eleven were much more extensive, the balloon on several occasions depassing the French frontier. In every instance incessant observations were maintained and numerous interesting experiments successfully made. Full details of these excursions were published in a volume styled, "My Twelve Voyages in the Air." It forms one of the most interesting and delightful books Flammarion produced.

August, 1870, saw the beginning of the disastrous war with Prussia. Flammarion was living in Paris when that great capital was surrounded by the German armies. All men of military age being called on to serve in the defending force, Flammarion, though always an "apostle of peace," donned the uniform of the National Guard and did his part creditably. As Captain of Engineers, he, with four others, was assigned the duty of observing with powerful telescopes the effect of the French artillery fire upon the batteries of the besiegers. His Lieutenants, Paul and Prosper Henry, members of the Observatory staff, were subsequently to become famous as the makers and users of the astro-photographic telescope with which the first star-charts of the heavens were made. Even while engaged in military duty demanding the closest attention, Flammarion managed to record some facts of scientific value; for instance, he pointed out that the report of a cannon fired at long range arrives before the projectile, because of the longer path and diminishing velocity of the latter, while sound is propagated in a straight line with uniform velocity.

When the disastrous war was at last terminated, Flammarion resumed his work as a writer and lecturer. His very important and delightful book, "The Atmosphere," was brought out in an edition finely printed and elegantly illustrated. Valuable as a scientific work, it also possesses great literary merit. Several

editions have been required to meet the demand, and though written more than half a century ago, it may still be read with profit.

In 1877 he published *Les Terres du Ciel*, a work designed to popularize astronomical knowledge, which was quite successful.

But the most notable and important of all his works was already in an advanced state and issued from the press in 1880. I refer to the "Popular Astronomy," a perfectly accurate scientific exposition of all the facts of the science, yet written with such clearness and perfection of style that the reader surmounts the difficulties of the subject almost without perceiving their existence. The mathematics of the subject are not shunned, but are stated in such clear and concise words as to be readily comprehensible by any person of ordinary intelligence. Enlivened by digressions and anecdotes, often droll, at times pathetic, the reader's interest is never suffered to flag. Copiously illustrated in the best style of the time, and finely printed, the book achieved wonderful popularity, and an unheard-of success. Issued at first in monthly parts at a price which even then was extremely low, its readers were reckoned by hundreds of thousands; and it undoubtedly has done more to awaken and maintain popular interest in astronomy than any book which had appeared before, or has been put before the public since. This fine work was "crowned" by the Academy, which also decreed a prize to the author.

So great was the interest aroused by the reading of the "Popular Astronomy," the author was fairly besieged with requests for more detailed and precise information, in particular with regard to the starry heavens. To the astonishment of everyone, he was able within one year to gratify the desire of his readers by bringing out, "The Stars and the Curiosities of the Heavens," published in 1881, forming an admirable sequel to the former work. Space only permits me to say that he has given therein a wonderfully comprehensive and accurate account of each and every star above the 6th magnitude visible to an observer in the latitude of Europe, and of many stars in the southern sky, with comparative tables of their magnitudes at different times from the earliest to the latest records, along with full details as to individual

stellar objects of special interest, and descriptions of the nebulae and star-clusters in the regions covered by the work.

About the same time appeared his Chart of the Moon, a lunar globe, and his first (small) globe of Mars. He also published a number of small works on scientific subjects, which I have to pass with this mere mention.

But for several years Flammarion had been engaged on a colossal undertaking, the primary stage of which was reached when he gave to the astronomical world the first volume of, "The Planet Mars and Its Conditions of Habitability," a remarkable and most valuable compilation of all important observational studies of this most interesting planet from the earliest period to 1892. A second volume followed in 1909. The vast amount of study, research, and actual labour which the preparation of these two volumes involved can scarcely be conceived, and space forbids any adequate attempt to enter into explanation. I will merely say, then, that the editing demanded most careful classifying, epitomizing, and translating from at least four languages, of the enormous mass of descriptive observations obtained from areographers throughout the world; and it will readily be seen the successful accomplishment of this must have constituted a labour of herculean magnitude. A third volume of the series, anxiously awaited by the students of Mars in many lands, was in course of preparation when the tireless author-editor laid down his pen forever.

I have been endeavouring to abridge as much as possible this paper, already longer than I had intended, though in doing so I have been compelled to pass without notice a host of investigations and researches, every one of which merits, and would repay, lengthy reference. I cannot, however, leave unmentioned one great achievement, the success of which undoubtedly gave Flammarion more genuine happiness than any other triumph of his long career. I refer to the founding of the *Société Astronomique de France*, an organization dear to him as an only child. This is not the place to dwell on the phenomenally rapid growth and enormous development of the Society, which sprang into existence from seed planted by his vigorous hand and cultivated by his untiring energy. To

the members of that Society he was not merely "the Founder," "the Master", but "the Father", a parent as beloved as honoured. On the title-page of the *Bulletin* of the Society for July, 1925, in which his death was announced along with a host of tributes to his genius and virtues, appeared these words: "The Astronomical Society of France has lost its Secretary-General, its Founder, its Father."

But I have been departing widely from chronological order, for I have still to recount events, so important they cannot be omitted from Flammarion's life-story, however briefly sketched. We recall that from his earliest years he had been an observer, ardently desiring means to study the stars on his own account. While relatively a poor young man, the possession of a small refractor used from a house-top gave him what he was content to call "An observatory of his own". Later he was "permitted" to work at the National Observatory (without remuneration), using an equatorial of moderate size, (though not of real excellence), and was accomplishing a research of very high value, when rudely interrupted by the jealousy of a petty official. That incident occurred in 1877. But in December, 1882, a new and far wider horizon was opened to his gaze, through the generosity of M. Méret, a wealthy citizen of Bordeaux, who had long been an unknown and silent admirer of the scientific work of the great astronomer-author. M. Méret presented Flammarion with a fine mansion situated in a beautiful park at Juvisy-sur-Orge, only stipulating that the gift was to be anonymous. But silence in that regard could not be maintained. Flammarion with characteristic energy commenced the alteration of the Chateau into an observatory, and by means we need not now explain, the change was soon effected, and a fine equatorial of .24m., (9.6 in.), the gift of Bardou, the eminent optician of Paris, duly installed in position and set to work. The investigations conducted at the Observatory of Juvisy have been most extensive, and are so widely known and so highly appreciated throughout the astronomical world, any attempt on my part to enter into details would be quite superfluous. Naturally the members of the solar system, and in particular the planets Venus and Mars, have been studied with the utmost

diligence; but all other branches of astronomical science have likewise received attention. In his practical work Flammarion was most fortunate in securing the assistance of MM. Antoniadi and Quénisset, the former temporarily, the latter permanently. One extensive and valuable contribution to our knowledge of the heavens deserves special notice, namely: a most careful study of all the nebulae and star-clusters in the catalogue of Messier; these objects being re-observed, drawn, and photographed, the recent investigations being preceded by summaries of all previous observations from the time the objects were discovered.

Thus Flammarion found his heart's desire gratified to the full, and always an "apostle of peace" might well look forward to many peaceful, but never idle, years; nor was this expectation unrealized. Indeed during 1914 and ensuing years, when the Germanic hordes invaded his beloved country, leaving ruin and horror in the train of their devastating progress, the aged astronomer was compelled to abandon his home and seek asylum in Southern France. But when at last the devouring swarm, routed and crest-fallen, had been expelled, he joyfully returned, thankful and happy, to find his Observatory of Juvisy unplundered, undesecrated. Whereupon, with lessened bodily strength, and diminished resources, yet brave of heart as ever, he confronted the situation and faced the duty of the hour; "To remake France!" War had swept the fairest region of the land as with the besom of destruction. "Take courage," he said; "the treasures of the heavens, unharmed, undimmed, are still ours."

Such was his attitude nearly seven years ago. He resumed his busy life, of which study and work were the daily program. No large volume appeared, but his keen intellect grasped the underlying principles of each advance made by modern science; and by expressing the essential points in that elegant and lucid language of which he had so long been a past master, he smoothed the way through difficulties, and made clear to his readers much which otherwise would have been incomprehensible. Particularly was he attracted by the marvellous results attained in the great observatories of the United States, through the possession of colossal

instruments and unlimited financial support. His discourses on these, chiefly in the form of communications to the *Bulletin* of the Society he had founded, evinced all the vigour of a clear and brilliant intelligence.

But he realized that far greater labours were demanding his attention. His principal works, "Popular Astronomy," and the others, compiled half a century ago, had become out of date and, left far behind by the progress of the intervening years, must be revised and practically re-written. None was more fully conscious of this than was the author himself. The revision and re-writing would have been a heavy undertaking even had he been forty years younger. For a man of his age it might well be deemed an impossible task. Still, vigorous in body, clear in intellect, cheerful and optimistic by nature, he doubted not his ability to carry out what he regarded as an imperative duty. To commence, he would re-write the "Popular Astronomy" and bring it out as a new and enlarged edition, with illustrations by the latest and best photographic methods. He set himself resolutely to work. Toward the end of May last the revision was making some progress.

For some time Flammarion had been suffering from rheumatic or neuralgic pains, but these symptoms appeared to have yielded to treatment: "he seemed invulnerable." To some friends, who, wondering at his activity, bodily and mental, would ask his age, he would reply: "I am twenty, four times." To Madame Flammarion, who had suggested a visit to his birth-place, "That he might be photographed where he had played when a boy," he replied: "That would be impossible, for as a boy I never played." *Work* was to him a recreation. So the days passed, and he worked.

On the morning of June 3, 1925, nothing gave warning of the fatality close at hand. He had been turning over his registers, making notes and extracts. Toward noon he went to a book-case and took out some cherished volumes, holding them lovingly in his hands. Then, seating himself on his divan, he dictated to Madame Flammarion a translation of a short article in *Nature*, entitled "Ancient Clepsydrae," which he intended for the *Bulletin*. Then he resumed the revision. The hour for *déjeuner* struck, and a very

simple repast was set out on a corner of his work-table, from which books and papers were moved aside. A short time after noon he went to the window and stood for a while admiring the beautiful landscape, bathed in the brilliant sunshine of a June morning. "What a lovely day," he said; "and my 'burning bush' is admirable." Then he turned as if to resume his seat. Madame Flammarion noticed that he had become pale and walked unsteadily; she supported him, and asked: "Is it that 'maudit' lumbago again?" "No," he murmured faintly; "my—heart." He tottered, and she caught him in her arms. *Camille Flammarion had died standing.*

The suddenness of the event, though it could not have been entirely unexpected, was a shock to the very large circle of his personal friends, and caused genuine sorrow to tens of thousands who knew him only through his writings. Letters and telegrams of sympathy by thousands came to his widow and other relatives. The feeling was universal that not merely the scientific world, but civilization in general, had suffered a great loss through the death of "A man, wise and good." Laid to rest in a tomb, "close to his much-loved observatory and his books," doubtless a fitting tablet will be reared to his memory; but his Works form a monument more durable than any inscribed stone, and his name will be kept in affectionate remembrance by hundreds of thousands of his readers who may never have opportunity to visit his last resting-place.

During his long life he gave to the reading public 55 works, all of scientific value and literary merit. Beside, he left unpublished nearly as many, some not completed. His contributions to the *Academy of Sciences* numbered 23. I have already referred to the distinctions conferred on him by that illustrious body.

Flammarion was twice married. His first wife, a widow, *née* Mlle. Sylvie Petiaux-Hugo, was a grand-niece of the great poet and author. Her death, following an apoplectic stroke, occurred on February 23, 1919. He subsequently married Mlle. Gabrielle Renaudot, a lover of astronomy from early childhood, who had become his amanuensis when, owing to failing health, Mme. Flammarion was obliged to relinquish that heavy duty.

The question has been asked: Did the author of so many popular works accumulate "a fortune?" It is to be feared he did not. Entirely devoted to science and literature, liberal, charitable, he was indifferent toward pecuniary matters. As an intimate friend once remarked: "Flammarion never seemed to know how much money he had in his pocket-book."

NOTE.—I am indebted for the *material* of this sketch almost entirely to documents which appeared some months ago in *La Nature*, and *L'Astronomie;* in particular, the outline of Flammarion's life by M. Em. Touchet, and the affecting narration of his last hours by Madame Flammarion. I have added a few personal references taken from his own writings.

THE NEW STAR IN PICTOR

By R. M. Motherwell

NOVA PICTORIS was first observed by Mr. R. Watson, of Beaufort West, South Africa, on Monday, May 25, at 5.50 a.m. In "The Journal of the Astronomical Society of South Africa" (No. 5, p. 157) he gives an account of the original discovery, which is well worth quoting here.

Mr. Watson was one of the discoverers of Nova Aquilae in 1918. To this he refers in the first paragraph. He writes as follows:—

In 1918, after the discovery of Nova Aquilae, a resident of Beaufort West said to me: "How did you do it? Have you got all the apparatus?" Others have asked me: "Do you know all the stars in the sky?" Well, the only apparatus used was a pair of spectacles; whilst my knowledge of the sky had to be very considerably assisted by reference to Norton's Atlas.

. . . . . .

It happened like this: I had to be at my work at 6 a.m. on Monday, May 25th, and, having to walk about half a mile southwards, I left my house at 5.45 a.m. Upon opening my door I saw a glorious vision of the planet Mercury. I knew it at once, but its brilliance astonished me. The zodiacal light was there, too, heralding the dawn. My sleepy head began to wake up and take notice. Turning down the street, Canopus first caught my eye, low down in the south-east, with the larger Magellanic cloud above it. In the south-west appeared the Southern Cross, and due south I noted Beta Carinae practically on a level with Alpha Crucis. Then the unfamiliar spectacle presented itself: further to the eastward, in line with Alpha Crucis and Beta Carinae, and at the same interval from the latter, I noted a pair of stars. I regarded them carefully and noted their position with respect to Canopus and the Magellanic cloud. My thought was, "I am sure there was no pair of stars there before." I almost returned to consult my atlas, but I did not care to keep an officer who had been on duty all night waiting, and I also realised that the news would be of no use to anyone before evening, so I proceeded on my way, making as careful a note of the position as I could. At breakfast time I was able to ascertain from Norton's Atlas that the fainter star must be Alpha Pictoris and—well, the unmarked star must be a nova. I then took its approximate right ascension and declination from

the atlas, and telegraphed the information to the Royal Observatory. I was conscious that I was acting rather hastily, but it was a public holiday, and I was afraid that the Observatory staff might be absent if I deferred wiring till evening. It is also very important, too, that a nova should have its spectrum photographed at an early stage.

That is my story; some people are astonished at my making this discovery. My astonishment is that all the Australian astronomers seem to have overlooked it.

I have seen the star on a good many evenings, but conditions have been very poor for estimates of its brilliance.

It was approximately 2.3 magnitude at discovery, rose next day to about 1.7, then dropped to magnitude 3 towards the end of May. Since then it has been steadily increasing in lustre, until this morning (Monday, June 8th), when I estimated its magnitude at 1.6 (the brightest I have seen it).

Harvard photographic plates give the history of Nova Pictoris for over thirty years, as it is visible on plates taken in 1889 and 1890, and also every year from 1894 to December 26, 1924, its magnitude throughout this period being about 12.7. On January 4, 11 and 13, of the present year, it was certainly fainter than the eleventh magnitude, and on February 18 it was fainter than the twelfth magnitude, but a plate of April 13 reveals an increase in brightness to magnitude three, many thousand times that of February 18, 1925. Just when this wonderful change started is not known.

A nova usually rises to its maximum brightness in a day or two and consequently most novae have passed, or at least reached, their maximum brightness before being discovered. Nova Pictoris, however, is abnormal in this respect. It reached its maximum brightness of first magnitude on June 10, more than two weeks after its discovery and nearly two months after the first record of increase in brightness.

The decline in brightness has been unusually slow. Beginning on June 10 it dropped a magnitude in about one week, and by June 20 the decrease was nearly two magnitudes. But during the next two months the changes were irregular, with a mean brightness rather greater than the third magnitude. By the middle of October it was below the fourth magnitude. So Nova Pictoris, while following the cycle of a typical nova, has had a period of visibility

of several months, whereas most novae are visible to the unaided eye for a matter of days or weeks.

Spectrum changes have been correspondingly slow but true to type. The fact that most novae have reached maximum light before being discovered has resulted in a scarcity of spectrum observations of novae during the increase in brightness, but the abnormally slow development of Nova Pictoris has given an exceptional opportunity. Nothing new has been revealed. Like other novae observed on the rise, it had a dark-line spectrum, F-type, until maximum was reached. Coincident with a decline in light came a sudden but characteristic change in spectrum, the wide bright lines of hydrogen and other elements being present. Comparisons with Alpha Pictoris in September gave the colour index as over three-tenths negative.

Dominion Observatory, Ottawa.

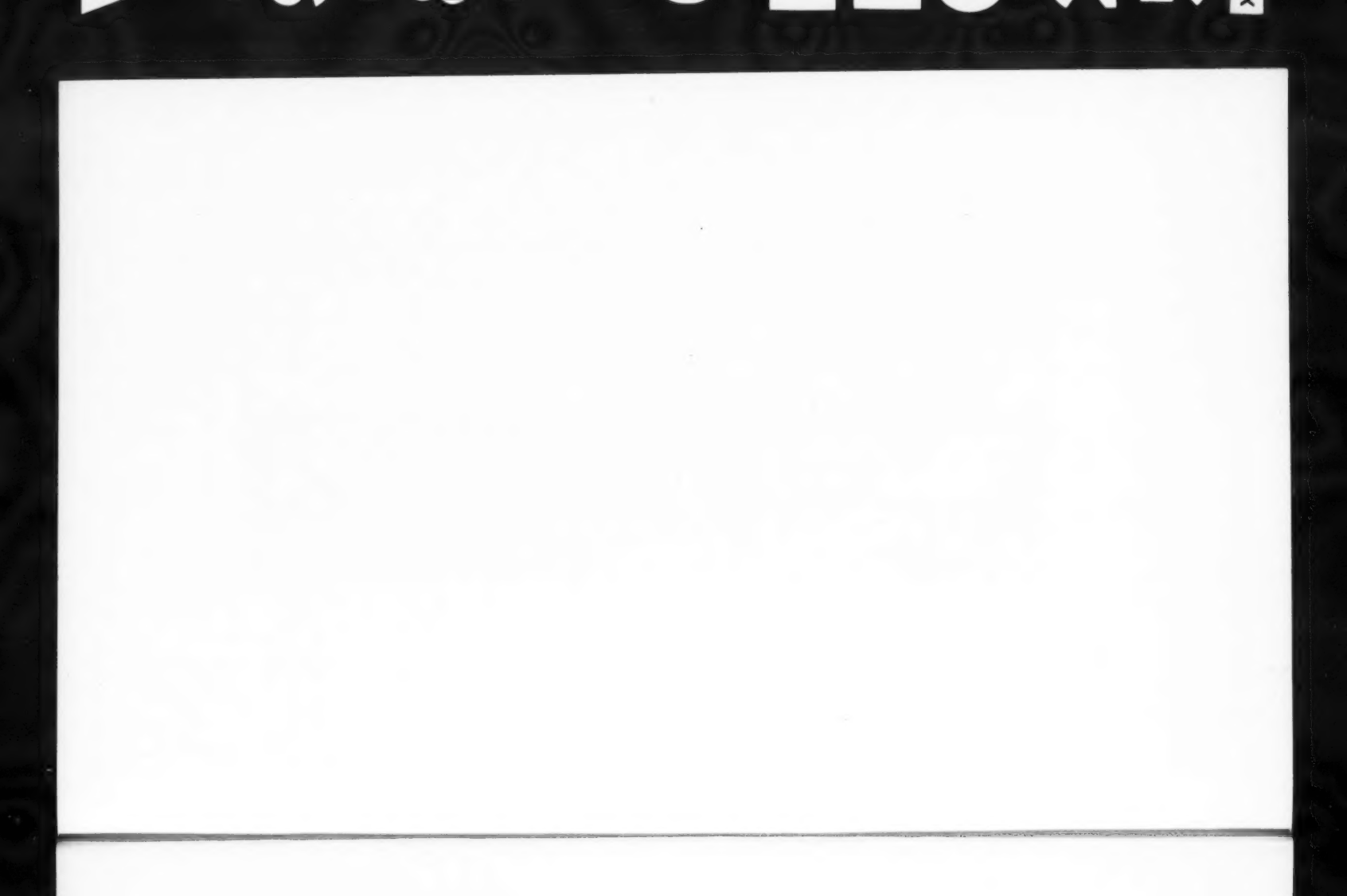
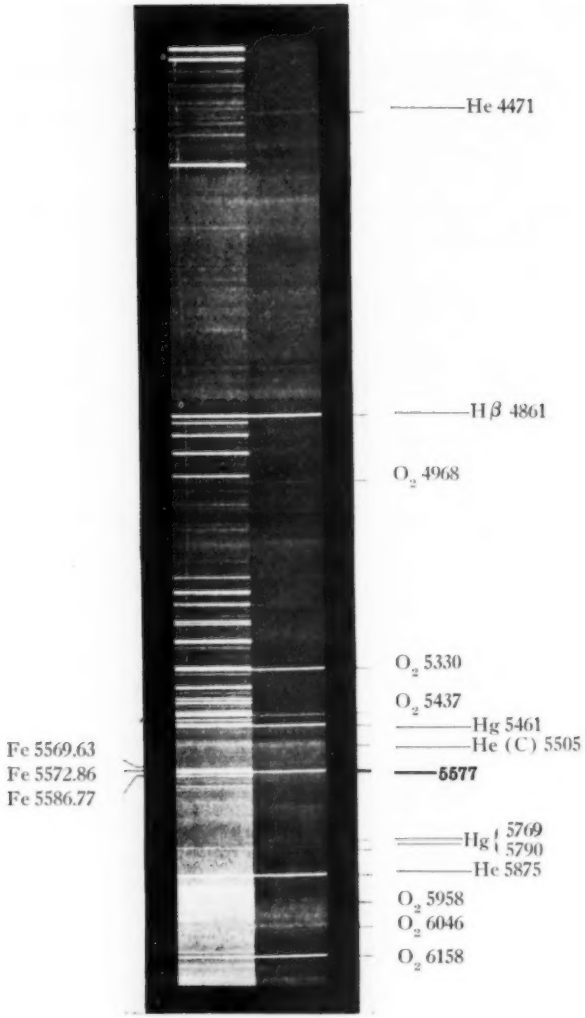


PLATE IX



Spectrum of Iron (left) and of a mixture of Helium and Oxygen

Journal of the Royal Astronomical Society of Canada, 1925.

RECENT INVESTIGATIONS ON THE AURORAL SPECTRUM

By H. J. C. Ireton

THE great interest in the Aurora Borealis and the problems associated with it is evidenced by the extensive list of careful investigations that have been published upon this subject.

The aurora is a phenomen of polar regions. It is most frequent in a zone about 20 degrees from the so-called poles of the aurora; the northern pole is approximately coincident with the intersection of the magnetic axis and the earth's surface. In the southern hemisphere the appearances of the aurora form roughly the mirror-image of those in the north, in a plane through the centre of the earth, perpendicular to the magnetic axis.

The Aurora Borealis is susceptible of the utmost variety of form, intensity and colour; and classification into various types is more or less artificial. Its colour is usually yellowish-green or greenish-white in the case of the diffuse forms; but blue, red, violet and other colours may occur in the more intense, moving varieties of the phenomenon. An average height for the aurora is 200 kilometres, although this varies with the form of the light, the height for the upper edge of the ray-like aurora being usually greatest and more than 200 kilometres. The height of the aurora is also a function of the latitude.

Since about 1716 it has been known that the appearance of the aurora is simultaneous with magnetic disturbances and the earth-currents connected with such disturbances. The connection, however, is far from simple, since there may be severe magnetic storms without any aurorae and conversely. Further, in lower latitudes it was found, about 1862, that the northern lights showed a period of about eleven years, the same as that of the variation of the sun spots; the maxima of the two cycles roughly coinciding.

Omitting the early theories, it is found that in 1893 Paulsen

suggested that the aurora was due to cathode rays produced in the upper atmosphere by the action of ultra violet rays from the sun. In 1896 Birkeland modified the theory by assuming that the cathode rays came from the sun, and in 1900 Arrhenius replaced the cathode rays by cosmic dust driven into the earth's atmosphere as charged particles by the pressure of the sun's radiation.

Birkeland's theory, and especially the development of it by Störmer is the most popular at the present time and suffices to explain the main distribution and variation of the aurorae. The direction of the arc in the aurora indicates that a negative charge is the agent at work, while the angular radius of the zone of maximum auroral activity agrees roughly with the assumption that the electron is the carrier of the negative charge in question. Since these cathode rays have such a high velocity, they must, as pointed out by Lenard, be produced by much harder rays than any we have on the earth. As early as 1903 Sir Ernest Rutherford and Professor J. C. McLennan observed effects due to these on their electroscopes, and recently Millikan has made measurements on this penetrating radiation.

The spectrum of the northern lights obtained after long exposure shows several lines of the negative band spectrum of nitrogen and in addition the famous auroral green line with wave-length 5577.350 I.A., identical with a similar line obtained in photographs of the spectrum of the night sky. It is this line which has caused so much interest and which was not known until recently to coincide with a line from any known element.

During the year 1924 Professor McLennan and Dr. G. M. Shrum undertook a study of the spectra of different gases under various pressures and intensities of excitation, and at the low temperatures now available at the cryogenic laboratory at the University of Toronto. As a result of this work they hoped to throw some light on the problem of the origin of the green auroral line. Vegard had suggested in 1923 that the origin of this line might be found in radiation from nitrogen having a suitable molecular constitution, provided that the nitrogen in this form was in a solid condition or in a vaporous state at low density and at low temper-

ature, with the molecules subjected to an electronic radiation. That such was the case was stated by Vegard as deduced from experiments carried on by him on nitrogen in the Leyden low-temperature laboratory. However, McLennan and Shrum, during a long series of experiments on the bombardment of nitrogen and of oxygen vapour at —252° C. by electrons of high and low speeds, found no trace of the green auroral line in the excited luminescence spectra of very cold nitrogen and argon. They were thus forced into disagreement with Vegard and were led to the conclusion that the origin of the green line could not be definitely connected with the elements nitrogen or argon. The improbability of Vegard's assumption had been pointed out by Atkinson, Grotrian and others, and experimental spectroscopic evidence was now also definitely against his conclusions. Babcock had found by careful interferometer experiments that the green line consisted of a single or double line having a separation of less than 0.035 A, while McLennan and Shrum found the luninescent band from solid nitrogen, on resolution, to consist of three broad lines.

During the year 1925 McLennan and Shrum continued their investigations on the production in the laboratory of the auroral spectrum. In view of the considerable evidence indicating that the composition of the upper atmosphere may be characterized by an excess of helium, they made experiments on the excitation of small quantities of air in large admixtures of helium. An analysis of the spectra emitted by these mixtures showed the green line and all the other well-known lines of the auroral spectrum.

Using an uncondensed discharge from a 60-cycle 3 k.v.a. 50,000-volt transformer, with about 30 amperes at 110 volts passing through the primary, it was found that in mixtures of helium and oxygen that the line of w.l. 5577 was greatly changed, while other auroral lines were absent. In experimenting with mixtures of neon and oxygen it was found that neon enhanced the line 5577 in the same manner as helium. Experiments with mixtures of helium and nitrogen did not produce the line, but the presence of helium greatly enhanced the negative bands of nitrogen. Thus there was produced, in studying the effect of large admixtures of helium and

of neon on the spectrum of oxygen, a hitherto unknown line (5577. 35A) which is very sharp and subject to great fluctuations in intensity. These characteristics, together with the agreement of wave-length, make its identity with the auroral green line a certainty. Plate IX shows the prominent character of the green line in a spectrum taken of a discharge in mixtures of helium and oxygen. It will be seen that all lines except 5577 have been identified as *strong* lines in the spectrum of helium, hydrogen, oxygen or mercury.

University of Toronto.

SUNSPOTS AND THE WEATHER

By Ralfh E. DeLury

VARIATIONS in the quantity or quality of the radiation received by the Earth from the Sun must produce changes in the weather. Differences in the energy received arise from changes in the Sun or the intervening space. The important problem of determining the nature and extent of these variations and their terrestrial consequences has for years attracted alike the astronomer, the meteorologist and the economist, and quite naturally the greatest attention has been given to the most obvious change in the Sun, namely, the variations in its "spots."

Large sunspots—being visible to the naked eye when the sunlight is weakened, sufficiently to be viewed, by haze in the atmosphere—have doubtless been observed for ages, but the earliest known records are those made by the Chinese from 188 to 1638 A.D. No doubt the Chinese ascribed to sunspots a terrestrial influence, as did also the Europeans whose observations, made with the telescope, commenced about 1610.

William Herschel in 1801, and Carrington in 1863, endeavoured to find a relationship between the variations in sunspots and the prices of corn. Later, in the seventies, W. S. Jevons, with more complete data, investigated this question very thoroughly and apparently deduced a relationship. Since then many investigations have been made concerning the possible influence of sunspots on a great variety of terrestrial phenomena, *e.g.*, magnetism, aurora borealis, cloudiness, rainfall, storms, lake levels, temperature, pressure, vegetation, and various conditions of living things, human and otherwise—some apparently indicating relationships, and others not. Perhaps, in view of the comparatively short records in nearly all of the fields studied, the most important of these is the investigation by Douglass of the annual growths of trees, which shows in some cases the relationship so well during the period of the reliable European observations of sunspots that a

fair estimate is possible of the nature of the spottedness of the sun back for many centuries.

The valuable long series of records[1] of the weather and the arrivals of birds, kept by Victor Chandon (*médecin*) and his family at Montdidier, France, from 1784 to 1869, reveals the relationship to the sunspot period of 11+ years in a remarkable way. These records have already been discussed by the writer in a paper[2] entitled "Bird Arrivals in Relation to Sunspots." From this it appears that rainfall was greatest, and dates of arrivals of birds latest, at the times of maxima of sunspots. It is of interest to present the mean curves of these records along with comparisons of certain other data in the mean for the same seven sunspots cycles of average 11+ years. In the Table are given the mean "sunspot numbers" for the years of minima, 1 year after, 2 years after, etc. The means—smoothed by the usual formula $0.25\ (a+2b+c)$—of rainfall (March+April, Montdidier), dates of arrival of birds (means for cuckoo, lark and swallow, Montdidier), tree-growth (Douglass for 11 sequoias, California)[3], commodity prices in Great Britain and Ireland,[4] and auroral frequency.[5].

The values given in the Table are shown in the accompanying figure. It seems highly probable that these various terrestrial phenomena vary simultaneously with the sunspot changes, whether produced by them or not. The most probable theory is that the variations in the solar radiation which accompany the sunspots produce directly changes in the Earth—and necessarily also in the other members of the solar system (it seems well established that the variations in the brightness of Encke's comet and the change in the rate of recession of the polar caps of Mars vary with the sunspots). It has long been known that magnetic and auroral disturbances are greatest when there are many spots on the sun. As a result of the increased ionization of the atmosphere—and it may well be also of increased matter from without—during the

[1]Annales du Bureau Central Météorologique de France, 1899.

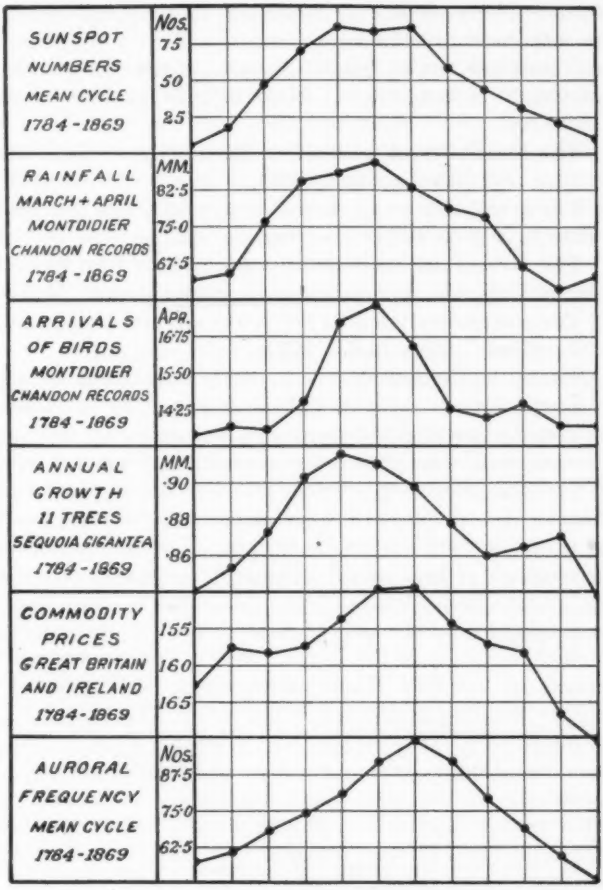
[2]The Auk, 40, 414-419, 1923.

[3]Climatic Cycles and Tree-Growth, 1919, p. 123.

[4]Todd's Mechanism of Exchange (as quoted in Bank Notes, Australia, Oct., 1922, by Dr. R. C. Mills).

[5]Chree, Ency. Brit.

sunspot maximum, greater cloudiness is induced which, with a possibly increased evaporation, causes increased rainfall in some localities. This in turn affects living things, and hence the varia-


SUNSPOT NUMBERS MEAN CYCLE 1784-1869
Nos. 75 50 25
RAINFALL MARCH + APRIL MONTDIDIER CHANDON RECORDS 1784-1869
MM. 82·5 75·0 67·5
ARRIVALS OF BIRDS MONTDIDIER CHANDON RECORDS 1784-1869
Apr. 16·75 15·50 14·25
ANNUAL GROWTH 11 TREES SEQUOIA GIGANTEA 1784-1869
MM. ·90 ·88 ·86
COMMODITY PRICES GREAT BRITAIN AND IRELAND 1784-1869
155 160 165
AURORAL FREQUENCY MEAN CYCLE 1784-1869
Nos. 87·5 75·0 62·5

Mean 11+ year curves for the period 1784-1869 of sunspots and terrestrial phenomena.

in vegetation and living conditions, the prices of commodities seem tion in bird migration, tree-growth, etc. As a result of the changes to be noticeably affected by the spot variations, in spite of the influence of wars and other serious human factors (indeed there is the possibility that wars being dependent on economic conditions are also influenced by solar variations).

Now, since the last minimum of sunspots occurred in 1923 the next maximum of sunspots will come in 1928 ± 1 year, at which time, probably—

(1) The March+April rainfall at Montdidier, France, will be greater than in 1923 by about 25 mm.;

(2) The average date of arrival of the cuckoo, lark and swallow at Montdidier will be 4 days later than in 1923;

(3) The average thickness of the annual ring of the oldest giant redwoods in California will be 0.07 mm. greater than in 1923;

(4) The commodity prices in Great Britain and Ireland will be about 10 per cent. lower than in 1923;

(5) The auroral frequency will be nearly double that of 1923.

Of course, these "probabilities" may be astray in each case due to irregular terrestrial factors, *e.g.*, volcanoes. Then, again, modifications will arise from other periodicities than the 11-year period. In this connection reference may be made to the periodicities of about 60 and 260 years which seem to be present in certain phenomena of the Earth and solar system. The fluctuation in the moon's longitude of long period, apparently incapable of explanation by gravitational factors (Newcomb, Brown), may possibly be due to changes in the unit of time caused by meteorological effects on the rotation of the Earth. H. H. Turner has found in the records of the Nile floods and Chinese earthquakes some evidence for the long period, while the writer discussed the California tree-growths (Huntington, The Climatic Factor) and the Upsala rainfall records, finding evidence in harmony with the 260 year period.

A 60+ year period found by Brown in the errors of the Moon's longitude was shown by him[6] to agree in phase with similar errors in the longitudes of the Earth and Mercury, and also with the pulsations in the extent of the 11 year maxima of sunspots. To

[6]Rep. B.A.A.S., Sec. A, p. 320, 1914.

account for all of which he suggested that as a result of the 60+ year period in sunspots there was changing magnetic action between the sun and the planets. The writer showed[7] that both the Upsala rainfall and the California tree-growths presented remarkable agreement in phase with this period as well as the 260 year period. Since then Douglass has found in his measurements of tree-growth over the same range of years a decided period of about 63 years. Thus the well-defined fluctuations in the errors of the Moon's longitude from the calculated longitudes of 60 and 260 years seem to have corresponding pulsations on the Earth; and since the 60 year period has a corresponding variation in sunspots in phase with it, it is suggested also that a 260 year period might be operating in the Sun as well—a suggestion which finds some support in the fact that discontinuities in the 11 year cycle seem to be indicated by Douglass' analysis of his tree-growth measurements.

Now it happens that these long periods, while not very accurately known, seem to reach their maxima not far from the present time. If, as seems likely, they are realities, there should result rather more than the average of cloudiness, rainfall, vegetation, etc., and the effects for the localities mentioned above might therefore be greater at the next maximum of sunspots than the average effect for sunspot maxima.[8]

If the cause of the variation in sunspots were definitely known, prediction of effects dependent on them could be made with more precision. During the past half-century the theory that sunspots are due to the action of the planets has been considered with

[7]Pub. Am. Astron. Soc., 23rd meeting, p. 85, 1919.

[8]Even if the probable weather conditions occur at the localities in question, there is no reason to suppose that they will be of sufficient severity to be greatly noticed except from a study of the records. The writer has been incorrectly reported as having predicted "weather never before experienced in the known history of man," "crop-failures in 1926-1927," etc., whereas at that time he had made no predictions whatever. Such predictions of calamitous conditions had been made by others, and the writer was interviewed concerning these and the question of long-period pulsations in the weather. Unfortunately, the reporter wrote an article in which were given those predictions of calamities along with some data, such as given above, supplied by the writer, with the result that the latter was wrongly quoted as having made the predictions.

increasing favour.[9] It is of interest to quote the following statement made by Jevons 50 years ago: "Now, if the planets govern the sun, and the sun governs the vintages and harvests, and thus the prices of food and raw materials and the state of the money market, it follows that the configurations of the planets may prove to be the remote causes of the greatest commercial disasters. It is a curious fact, not sufficiently known, that the electric telegraph was a favourite dream of the physicists and romanticists of the sixteenth and seventeenth centuries. It would be equally curious if the pseudo-science of astrology should, in like manner, foreshadow the triumphs which precise and methodical investigations may yet disclose, as to the obscure periodic causes affecting our welfare when we are least aware of it."

MEAN VALUES FOR THE 11+YEAR CYCLES, 1784-1869

Years after Sunspot Minima	Mean Sunspot Numbers	Montdidier Mean Mar.+Apr. Rainfall mm.	Montdidier Mean dates of Bird Arrivals April	California Tree-Growths 11 Sequoiae Gigantea mm	Commodity Prices Gt. Britain and Ireland	Auroral Frequency
0	0.0	64.1	13.4	.840	162.7	58
1	17.5	65.3	13.7	.853	157.6	61
2	46.4	76.0	13.6	.873	158.4	68
3	70.0	84.1	14.5	.903	157.5	74
4	85.7	85.8	17.2	.915	153.8	81
5	83.7	88.1	17.8	.910	149.7	92
6	85.6	82.9	16.4	.898	149.4	99
7	58.1	78.4	14.3	.878	154.3	92
8	43.9	76.8	14.0	.860	157.1	79
9	30.9	66.7	14.4	.865	158.1	69
10	21.0	62.0	13.7	.870	166.8	59
11+	10.3	64.8	13.7	.838	170.8	51

Dominion Observatory, Ottawa.
December, 1925.

[9]A plausible treatment of this subject has just come to hand, in L'Astronomie for November, 1925, where Jean Malburet deduces a mathematical curve which fits the sunspot curve with marked agreement. He considers the actions of the Sun, of the planets Jupiter, Earth, Venus and Mercury, when three at a time act in line with one another.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

A Hundred Years Behind the Time

The present writer had the great privilege of attending the International Geographical Congress which met in Cairo last April, and afterwards of seeing some of the remarkable remains of Egypt's ancient civilization. The Royal Geographical Society of Egypt was founded in 1875, and its golden jubilee was celebrated at a special session of the Congress.

In the vestibule of the Society's fine building was an exhibition of maps, books, globes and other things of interest to the visitors. Among these was a terrestrial globe bearing the name of a large publishing house in Paris. On examining it I found the present boundaries of the countries of Europe were properly indicated, but on turning to America I was astonished to see how utterly out of date it was. Of course I looked for Canada, and found that the largest city in Ontario was given as "YORK or *Toronto*". It is true that in the early days the name York was used, but it was discontinued in 1834 when the city was incorporated. I also found the old city of Kingston was given, but some of more recent growth, such as Hamilton and London, though several times as large as Kingston, were not mentioned.

In the western portion of the United States and Canada one might expect to find the names of many important cities and towns, but instead of that the names of various Indian tribes—Apaches, Crees, Blackfoots, etc.—were distributed over the country as though they still occupied the land.

Two Fire-Balls Seen

Mr. W. T. H. Waterfield, of Nakusp, B.C., gives the following description of a brilliant fire-ball seen by him.

On the evening of Thursday, the 12th November, I was strolling with a friend, when our attention was attracted by a very bright greenish light which clearly lit up the surroundings. My friend

turned round in the right direction quicker than I did and saw more of the phenomenon, but being ignorant of the constellations, was unable to put his knowledge to account. I saw an extremely bright pear-shaped object estimated at about 5′ of arc in diameter moving rather slowly from about five degrees above Polaris towards the North-West horizon. The time was almost exactly 8.23 p.m. Pacific time, and the meteor vanished on the same level as Vega and about 20 degrees more north in azimuth. The colour was a brilliant green, like an electric arc light, and I saw two or three bright glowing red (from contrast?) points detached and left behind in its flight. My friend spoke of a bright red tail, but I did not see this. Duration of flight was about three seconds—at least, what I saw.

After the first shock of astonishment was over, for this was the first fire-ball I think I have ever seen, it occurred to me to listen for the sound of an explosion, and I started to count seconds. I counted to 60 and then gave up, but about two minutes afterwards a very distinct explosion was heard in exactly the direction in which the meteor had vanished. Allowing for errors, both in the judging of direction and of time, I should think that the explosion took place at a point about 30-40 miles away, and about 30 degrees north-west of this town.

The night was very hazy, and only the brighter stars could be seen, or the path might have been traced with more accuracy.

In a telegraphic despatch from Ottawa to Toronto newspapers, dated December 17, it was stated that J. A. Bergeron, night-watchman of the Gatineau Company, early on the morning of the 17th, "saw a meteor fall from the sky, and in a mass of flame it passed about forty feet above his head, travelling at a tremendous speed. He claims that it was almost the size of a small barrel, and made a terrific noise. No other reports of the occurrence have been heard."

In this report the estimated size and distance are pretty certainly wrong, but the rest of the story is reasonable enough. It is regrettable that the objects themselves were not observed as they reached the earth. C. A. C.

MEETINGS OF THE SOCIETY

At Toronto

November 17, 1925.—The regular meeting of the Society was held in the Physics Building at 8 p.m., Mr. A. F. Hunter in the chair.

Messrs. H. A. Turner and F. S. Hogg, of Toronto, were elected to membership in the Society.

Mr. A. F. Hunter remarked that although many attempts must have been made to photograph the shadow bands visible during the eclipse of January last, very few results have appeared in the periodicals. He showed a slide made from a photograph taken by a professional photographer, Mr. Glen Lowry, in Stroudsburg, Pa., using a Graflex camera with an F 4.5 lens and 1/1000 of a second exposure. The bands were quite plainly visible on the smooth surface of snow, presenting a wave-like appearance. Using a foot-print in the snow as a measure, the bands were calculated to be about 18 inches apart. Secondary bands were also visible. Dr. Chant described the shadow bands seen at various eclipses—those observed in 1922 in Australia being very faint, while at Colorado in 1918 they were very plainly visible.

Mr. A. F. Miller reported that the large sun spot seen last month returned about the 7th November diminished in size, and that most of the smaller groups have disappeared.

Mr. A. F. Miller read a biographical sketch of Camille Flammarion. (It is printed in the present issue, see page 265.)

Mr. F. T. Stanford showed a moving picture representing a trip to the moon, which brought out the appearance of the surface of the moon very well.

December 1, 1925.—A regular meeting was held in the Physics Building at 8 p.m., the Vice-President, Mr. A. F. Hunter, in the chair.

Giving the predictions for December, the chairman described the positions of the major planets during the month.

The following were elected members:—

Cyril Ellis, North Battleford, Sask.
P. M. Millman, Wycliffe College, Toronto.
R. D. Mackay, Davisville Ave., Toronto.

Mrs. W. Gore, Long Branch Park, Toronto.
Miss A. E. Powell, 100 Delaware Ave., Toronto.
Miss C. Andrews, 373 Markham St., Toronto.
Miss W. A. McMath, 104 Charles St. W., Toronto.
Miss R. H. Allen, 2 Munro Park Ave., Toronto.

Speaking of the sun spots for the past fortnight, Mr. A. F. Miller described a group that had considerable importance. All the groups lately have been long and narrow. Some astronomers have recently observed spots appearing on the planet Venus for short times.

Mr. W. E. W. Jackson also spoke of the unusually large group of sun spots appearing for some time lately. It has been definitely observed that auroras have been increasing of late in number, and the disturbances of the earth's magnetism have also been increasing.

Mr. S. J. McKnight mentioned that he had observed one of the Andromeda shooting stars on the night of November 22, at 9.15 p.m., but these meteors have not been numerous of late years.

Prof. Chant drew attention to the discovery of a new comet of the 8th magnitude in or near Ursa Major; also to a daylight meteor which had been seen on November 15 near Boston, and was very brillint.

The address of the evening was given by Prof. C. A. Chant on "The International Geographical Congress". After describing in an entertaining way the journey to Egypt and Cario, where the Congress was held last spring, and the cordial treatment of their party, which consisted of Mrs. Chant who accompanied Prof Chant, with Prof. Pakenham and Mrs. Pakenham, by the reception committee at Alexandria, the speaker went on to describe the Congress itself. It was divided into five sections, viz.:

1. Mathematical Geography, which included the making of maps, etc.
2. Physical Geography.
3. Biological and human Geography.
4. Anthropological Geography.
5. History of Geography and Historical Geography.

Taken altogether, the Congress was fairly successful, notwithstanding some evidences of inexperience in managing such assemblies on the part of those in charge. He quoted the titles of a number of the papers read before the meetings, at which about 100 were read.

Subsequently, the delegates in attendance at the Congress were entertained at a banquet, at which the refreshments were extraordinary, and a reception in the King's Palace. In the Cairo Museum they saw the famous relics of King Tutankamen; they were also taken to the famous pyramids one afternoon. At Memphis, statues of Rameses II were to be seen everywhere, and they also visited Heliopolis. They took the trip to Luxor, travelling the 500 miles by train to save time. They saw the famous temple

of Karnak, and visited the Valley of the Tombs of the Kings, also the two colossal statues of Memnon. The address was enlivened by a fine series of lantern views, from negatives which Prof. Chant himself had taken on the trip.

At Victoria

Minutes of the meeting of October 2, 1925.

October 2.—The meeting of the Society was held at Victoria College (Craigdarroch), at 8.00 p.m., the president in the chair. Two gentlemen were elected to membership in the Society, J. A. MacKenzie, Dunsmuir Hotel, Eighth Street, New Westminster, B.C., and John Bartholomew, 1115 Fort Street, Victoria B.C.

The address of the evening was delivered by Dr. J. S. Plaskett, Honorary President of the Victoria Centre, on the subject: "The Cambridge Meeting of the International Astronomical Union".

The speaker first described the chief points of interest visited; slides of the cathedrals, such as Litchfield and Ely were exhibited, as well as photographs of Colleges and several scenes in the heart of London, all of which were intensely interesting.

The lecturer next spoke of the meetings attended. One of the most interesting of these was that of the Royal Astronomical Society held on June 12th. This function opened in a delightful manner, the members partaking of tea before commencing the business, which began at 5 p.m. This meeting was of particular interest because it was the occasion of the presentation of the Gold Medal to Sir Frank Dyson, the Astronomer Royal, for his work on the proper motions and the stream theory of the stars. The President, Dr. J. H. Jeans, gave a paper on a new theory of the formation of double-stars, which was discussed by Eddington in a very spirited manner.

A newly improved clock installed at Greenwich was described by Dr. Plaskett. In this clock the actual time-keeping is done by a free-swinging pendulum which receives an impulse every few seconds, while the mechanical work is done by a "slave" clock controlled by the pendulum.

The meetings of the International Astronomical Union were now spoken of. This body does not embark on new research, but confines itself to work already done. It sits in judgement on problems of importance to all astronomers, which cannot be settled individually, such as the question of time, or the deciding upon standard wave-lengths of spectral lines.

The work of the "Carte du Ciel" was reviewed by the Union, it being found that 25 years, at least, must elapse before the chart is completed, when 1,000,000,000 stars down to the 20th magnitude will be embraced by it.

Other features of the Union, such as the committees on Photometry,

Spectral Classification, Radial Velocities, Standard Velocity Stars, etc., were discussed by the speaker.

Slides were shown throughout the lecture, the speaker concluding by showing photographs of notable English and visiting Astronomers.

November 16.—The meeting of the Society was held at Victoria College at 8.00 p.m., the president in the chair.

Mr. F. L. Farrington, 14 Government St., was elected to membership in the Society.

The address of the evening was given by the Rev. Mr. Connell, on "Ancient Volcanoes of Vancouver Island".

The speaker commenced by referring to the relation between geology and astronomy, pointing out that they are mutually beneficial and should be studied together for a better understanding of our planet. The source of ejected volcanic matter, which are gases, ashes, and lava, was shown to be a layer or zone below the earth's crust, termed a "layer of weakness", which, upon any change of external pressure, is ready to force the molten materials out of cracks in the crust.

The kinds of materials ejected and their influence on the shape of the volcanoes was next discussed by the speaker, who emphasized the fact that neither flaming cones nor spectacular outbursts of gas and ash are necessary to volcanic action.

Passing on to particular cases the lecturer described the formation of Southern Vancouver Island rocks throughout geological record, and the different volcanic periods. Many interesting specimens were exhibited, bearing out the facts and theories put forward.

The lecture was illustrated throughout by lantern slides, many of them taken in the close vicinity of Victoria, and a hearty vote of thanks was tendered at the conclusion of the address to Mr. Connell for his instructive talk.

December 3.—The annual meeting of the Society was held at Victoria College at 8.00 p.m., the president, Mr. Duff, in the chair.

The annual reports of the Secretary and Treasurer were read and confirmed.

The President gave an address reviewing the principal scientific achievements of the past year, as follows:

The early part of the year was distinguished by the total solar eclipse of January 24th, although adverse weather conditions hampered most of the observers. It was noted that sun spots were now approaching a maximum. Noteworthy planetary configurations were touched upon as well as the discovery of a new star, Nova Pictoris.

Two new observatories are in the process of erection, one in South Africa, the other in Java.

Interesting experiments in physics and astrophysics were described, the outstanding experimenter being Michelson.

Work has been progressing on the atmosphere of Mars, the latest plates seeming to show positive evidence of such.

The work done on the companion to Sirius was spoken of at some length. This remarkable body, though very small, has a density of the order of 50,000 times that of water, although being in a gaseous condition.

Latest measures of the parallax of the Andromeda nebula seem to point to a distance of about 1,000,000 light years.

The lecture was very comprehensive in its outline and a hearty vote of thanks was tendered Mr. Duff by all present.

After a short discussion and several questions the business of the election of officers for 1926 was dealt with, the following being unanimously elected:—

President—Prof. P. H. Elliot.

Vice-President—Mr. K. M. Chadwick.

Secretary-Treasurer—Mr. R. G. Miller.

Recorder—Mr. R. M. Petrie.

Council members as follows:—Messrs. E. E. Blackwood, J. P. Hibben, J. A. Pearce, H. H. Plaskett, and past presidents.

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EDITOR
C. A. CHANT
University of Toronto, Toronto

ASSOCIATE EDITORS

J. S. PLASKETT
Director of the Dominion Astrophysical Observatory, Victoria, B.C.

SIR FREDERIC STUPART
Director of the Meteorological Service of Canada, Toronto

R. MELDRUM STEWART
Director of the Dominion Observatory, Ottawa

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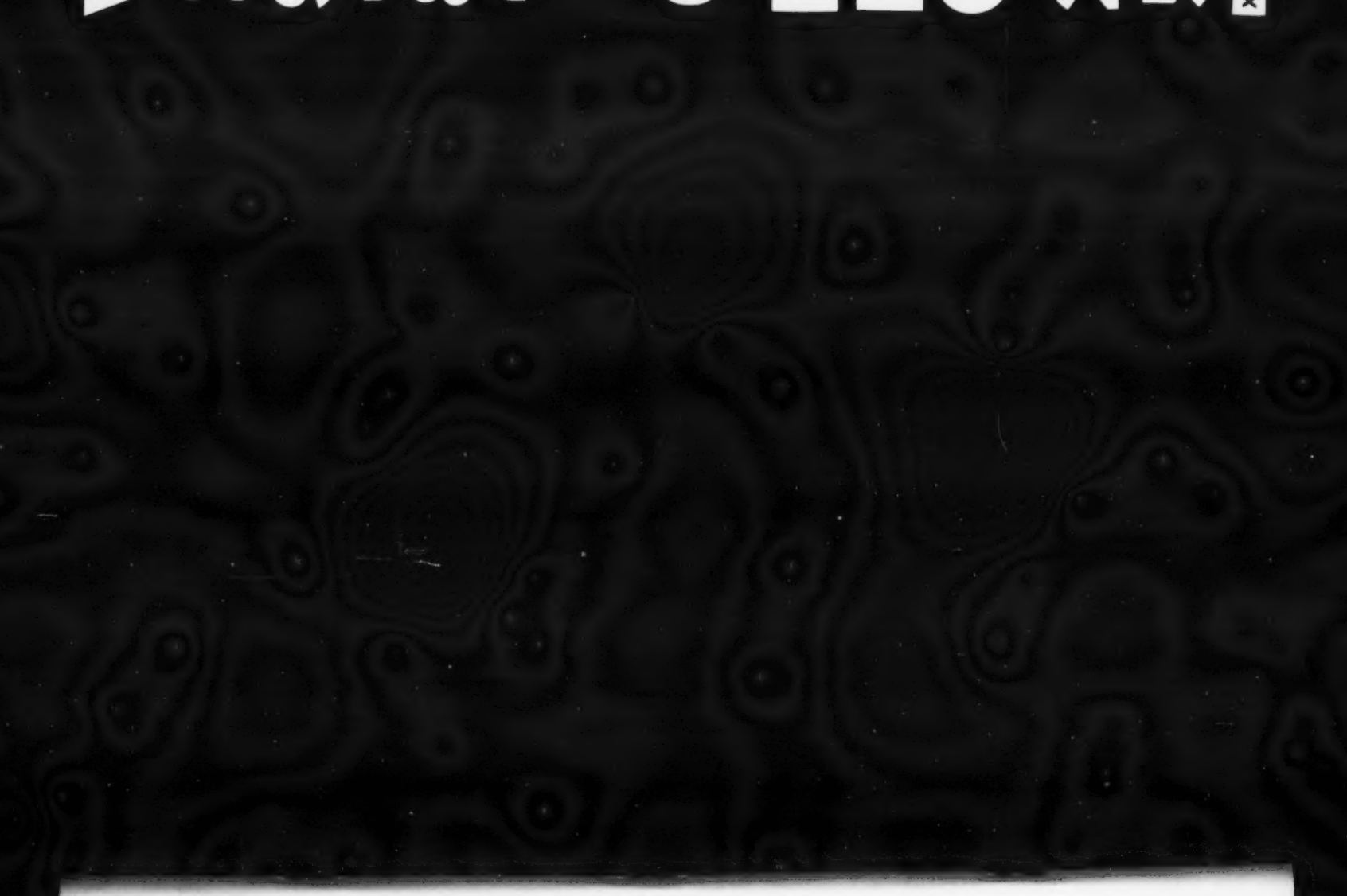

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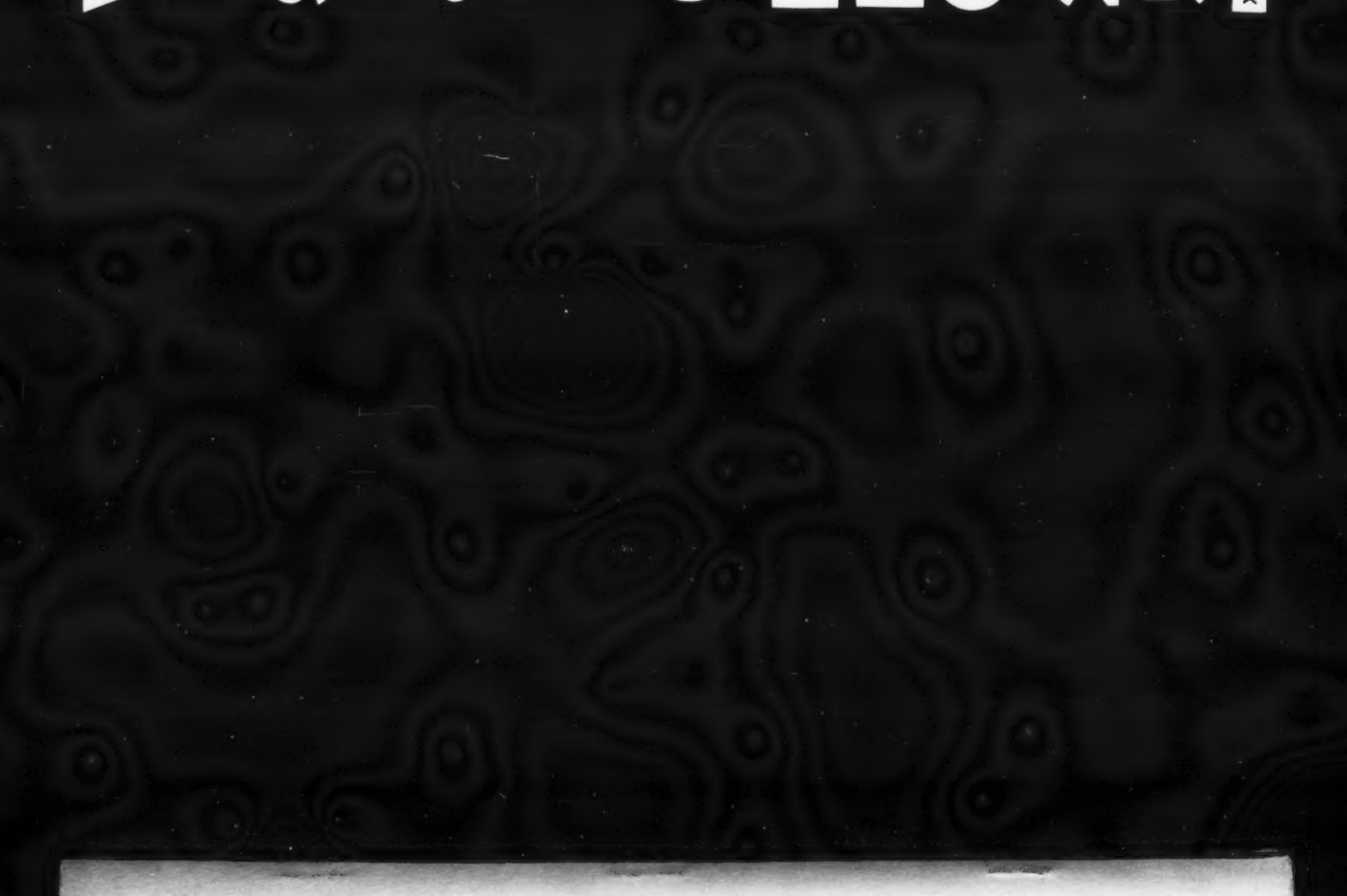
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